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ABSTRACT

A project was conducted at State Fair Community College (SFCC) in Sedalia, Missouri, to develop an associate of science degree curriculum in renewable energy resources and their application in agriculture. A pilot study, designed to verify and rate the importance of 138 competencies in fuel alcohol production and to ascertain employment opportunities in the area of renewable energy resources and their application in agriculture, was administered to 202 potential employers in fuel alcohol production. Data showed a need for 447 trained people by 1983. As a result of the response to the competencies needs assessment survey, seven new courses were identified for the agricultural energy associate of science degree program (in the areas of agricultural energy production, the chemistry of the energy process, agricultural biology, alcohol fuels, and solar energy), and an agricultural energy program was designed to mesh with three existing agriculture programs currently offered at SFCC. The final stage of the project involved preparation of a final report summarizing employment opportunities, suggested curriculum, and facilities and equipment needed to implement the program. (Attachments to the report include a schematic for a farm-size renewable energy system and the competencies and labor needs assessment questionnaires.) (MN)

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FINAL REPORT

**A Project To Develop An Associate Of
Science Degree Curriculum In Renewable
Energy Resources And Applications In
Agriculture**

81-131/132-600-7(B)

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July, 1981

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Research Coordinating Unit
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U.S. DEPARTMENT OF HEALTH
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ABSTRACT

TITLE: A Project to Develop an Associate of Science Degree Curriculum in Renewable Energy Resources and Applications in Agriculture

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INSTITUTION: State Fair Community College

LOCATION: 1900 Clarendon Road, Sedalia, Missouri 65301

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STARTING DATE: July 1, 1980

ENDING DATE: June 30, 1981

OBJECTIVES OF PROJECT:

The major goals of the project were:

1. Conduct a pilot study to ascertain employment opportunities being created in the emerging renewable energy resources and applications area of agriculture.
2. Compile a list of competencies required for the occupations identified.
3. Design a two-year degree program in the application of renewable energy resources in agriculture.
4. Prepare a final report summarizing (a) employment opportunities, (b) suggested curriculum, and (c) facilities and equipment needed to implement the program.
5. Implement a two-year degree program in renewable energy resources and applications in agriculture.
6. Develop and distribute mediated instructional materials in renewable energy through the college's Media Center.

Seven new courses have been identified for the "Ag Energy" Associate of Science Degree Program. The "Ag Energy" curriculum will be delivered through the SFCC Agriculture Department. Students in other areas of agriculture will have the opportunity to enroll in Ag Energy courses as electives.

Agricultural students need this educational program to become energy self-sufficient. Renewable energy industries need trained people to operate their plants and install their equipment.

The implementation of this degree program will enable SFCC to train students for jobs in a new and emerging industry and educate farmers and agri-business in energy production from domestic sources.

Statement of the Problem

The United States is facing an acute energy crisis. Almost daily in the press, on television, and on the radio Americans are reminded of this crisis. Projected needs for energy appear to outstrip available supplies.

At the root of the energy crisis are our runaway demands for oil, natural gas, and electricity. The price of gasoline has exceeded \$1 per gallon in mid-Missouri, and the latest predictions are \$2 per gallon by the end of 1981.

The once mighty dollar has lost its buying power and the world has feverishly traded dollars for gold. Billions of petro-dollars are being exchanged for gold, causing this scarce commodity to fluctuate wildly in price.

The billions spent by the United States for foreign oil has created a substantial deficit in our balance of trade. Agricultural commodities, even though we have a tremendous supply, have not kept pace in price or quantity to offset the petro-dollars being sent to the OPEC nations.

The United States' demand for energy has continued to increase annually. The energy growth rate is about 7 percent per year. To maintain this 7 percent growth requires an energy output that would double in about 10 years. By the year 2000 we would be using 8 times as much energy as we did in 1970. This increased demand for energy in the United States has been sustained primarily by oil and gas.

During the past 25 years oil has been taking the place of coal as one of the primary sources of heating in addition to the use of petroleum products to fuel prime movers and to make electrical power. During this period of time there has been a doubling in the demand for petroleum products every 10 years. Practically all the increase in energy consumption after 1970 in the United States came from oil imports. Oil is the mainstay of the U.S. energy economy--furnishing approximately 50 percent of the total energy consumption. The United States imports about 45 percent of all the oil used in this country. Most of these imports come from the middle eastern countries.

In this era the abundant availability of oil, its convenience, and its lower price led to a substitution of coal by oil and, in general, the creation of an energy buyers' market. After 1973, when the supply of foreign oil was interrupted, the bargaining advantage suddenly and heavily shifted to the side of the exporting countries. The price increase has been associated with a fear of scarcity. The world's supply of oil is not unlimited--most sources indicate that at the present rate of consumption the world's known reserves will be exhausted within the next 20 or 30 years. The growth and availability of energy supplies in the United States can be maintained only if adequate measures are taken now to develop other energy sources and to conserve the fossil fuels.

Auto manufacturers in the U.S. have not been world leaders in conservation. European and far eastern auto manufacturers have pioneered the small, fuel-efficient autos, while Detroit has streamlined the large cars that guzzle gasoline. Only after extremely hard times

befell them in 1980, did the U.S. auto makers begin manufacturing the small, fuel efficient autos. Time will tell whether the Japanese and European cars will continue to outsell the U.S. models.

One of the more promising alternative energy sources for agriculture and transportation in the Midwest Agricultural Belt is fuel alcohol--fuel alcohol may be added to gasoline to make gasohol or burned directly. The production of fuel alcohol from agricultural products offers the following advantages:

1. It is made from renewable sources--grain and sugar beets.
2. Waste products such as spoiled grains can be used in the process.
3. The process not only produces fuel alcohol, but a valuable, high-protein feedstock.
4. It is based on an existing low-technology approach, and production units based on the needs of the individual user can be quickly installed.
5. The conversion on internal combustion engines to burn fuel alcohol is a relatively simple process.
6. It is a cleaner burning fuel than gasoline and offers less environmental problems.
7. It offers the farmer an alternative market for his surplus grain.

The production of alcohol dates back to 4000 B.C. when the Middle Eastern people were fermenting crude beers and wines. The distillation of alcohol from fermented grains (rice) was being done by the Chinese around 800 B.C. Several B.C. vintage stills were invented--notably the Tibetan Still, utilizing a simple clay pot which was heated to drive

off the alcohol vapors. The Peruvian Still added a few refinements to increase volume, and the Tahitian Still incorporated a pipe to run the alcohol through cool water for condensation. By 200 B.C. the Egyptians were utilizing breweries for production of alcohol.

By 500 A.D. distillation technology had advanced to the point where alcohol was being used in cosmetics, perfumes, and medicines. Around 1300 A.D. Renaissance Europe had developed a new kind of condenser called a Worm. The Worm was a coiled pipe or tube that led from the still through a container of cold water. This increased the surface area of condensation, therefore increasing the purity and quantity of alcohol.

The 18th century produced major discoveries in chemistry and distillation technology. Ethanol was being produced from a variety of organic materials. Most of the 18th century technology and previous technology were devoted to the distillation of alcohol for beverage purposes.

The 19th century produced technology that made alcohol recognized for its industrial uses--primarily heat and fuel. In 1801 the Adam Still was invented. This still was the first to be used on an industrial scale. The discovery that wood wastes treated with sulfuric acid yielded a product that contained sugars suitable for fermentation was made in 1819. The continuous Still was perfected during the 1820s. This still allowed the mash to be loaded and alcohol distilled without shutting the still down.

In 1823, through the destructive distillation of wood and then condensation of the gases, methyl alcohol was discovered. The column still was invented in 1826. This concept of forcing steam through layers of

mash spread over perforated plates in the columns allowed commercial production of 94-96 percent pure alcohol.

The combination of the column still and the continuous processing made it possible to manufacture ethanol in large quantities. It then became available as a viable fuel by the 1830s. During the next decade ethanol was mixed with turpentine, coal tar, and naphtha for fuel in lamps. Ethanol began replacing whale oil as a popular fuel.

In 1861 the first federal tax was placed on alcohol. The taxes made alcohol too expensive to compete with kerosene as a fuel. Rising taxes on ethanol for the next three decades caused methyl alcohol, produced by destructive distillation of wood, to be substituted as a fuel.

In 1876 the first modern internal combustion engine was invented. The otto cycle engine was designed to run on alcohol. In 1907 the U.S. tax laws were changed regarding denatured alcohol for fuel, (95% ethanol, 5% toxic additives). The interest in denatured alcohol for fuel was re-kindled immediately. In 1907 the USDA published a report entitled Uses of Alcohol and Gasoline in Farm Engines. In 1909 the U.S. Geological Service published Bulletin No. 392 entitled Commercial Deductions from Comparisons of Gasoline and Alcohol on Internal Combustion Engines. This bulletin showed that alcohol gave greater horsepower, higher compression, and the same mileage--but lower thermal efficiency--than gasoline.

World War I produced a shortage of petroleum, and alcohol production was expanded. European countries expanded their production extensively. Post-war use in Europe continued. Sweden produced ethanol from sulfite liquors and blended it 25/75 with gasoline as motor fuel. Germany produced

ethanol from agriculture; 2/3 potatoes, 1/3 molasses, grains, and sulfite liquors. The U.S. had post-war surpluses of ethanol that were blended with gasoline 20/80 and sold in some cities. As late as 1930, the Chrysler Motor Corporation produced cars slightly modified to burn straight alcohol fuel and shipped them to oil-poor New Zealand. International Harvester advertised motor trucks in the Philippines "Powered with engines especially designed to burn alcohol."

In 1922 Alexander Graham Bell called alcohol, "a beautifully clean and efficient fuel which can be produced from vegetable matter--waste products of our farms and even garbage of our cities." In 1929 Henry Ford predicted no shortages of fuel for the internal combustion engines of the future. He said, "We can get fuel from fruit, from sumac by the roadside, or apples, weeds, sawdust, almost anything. There is fuel in every bit of vegetable matter that can be fermented. There is enough alcohol in one year's yield of an acre of potatoes to drive the machinery necessary to cultivate the field for a hundred years."

Henry Ford was an alcohol fuel proponent. During the Great Depression years, Ford campaigned vigorously for a potential market of farm products into alcohol production. Henry Ford sponsored three National Conferences in Dearborn, Michigan, in 1935, 1936, and 1938 to discuss the use and development of grain alcohol blended fuels. In 1938 the USDA published a study entitled Motor Fuel From Farm Products. Again, the attributes of ethanol for fuel were positively concluded by the study.

World War II increased production of alcohol to an all-time high of 519.9 million gallons in 1944, as compared to 86.9 million gallons in 1934.

Alcohol production from grain increased from 5.5 million gallons in 1934 to 313.6 million gallons in 1944. During the war years the United States whiskey distilleries were commandeered into war production of fuel alcohol. Alcohol was used to power war ships, tanks, and airplanes. It was discovered that a 20/80 blend of alcohol and aviation fuel increased the speed of our fighter planes as much as 60 mph. The allies destroyed most of the East European oil refineries early in the war, so Hitler converted his war machines to alcohol. Captured Japanese planes in the Pacific revealed alcohol as their fuel source.

The early 1950s marked the end of farm products as a large source for industrial alcohol. Since then, synthetic alcohol from fossil fuels has dominated the alcohol markets. Alcohol for fuel was immediately taken out of market by an abundant and cheap supply of gasoline.

The dramatic increase in the price and the decrease in availability of gasoline have awakened many Americans. The sporadic interruption of foreign oil supplies, and the prediction of shortages and higher prices for gasoline and fuel oil, have led a grass roots movement toward the production of fuel alcohol. Grain farmers, faced with rising production costs and huge surpluses of feed grains, have led the fuel alcohol movement.

In 1971, the Nebraska Legislature enacted legislation providing for the establishment of The Agricultural Products Industrial Utilization Committee to administer The Nebraska Grain Alcohol Program. Extensive research was conducted by this committee; although, most notable was The Nebraska Gasohol Two Million Mile Road Test. This test showed promising results such as: five percent less consumption of gasohol

than for unleaded gasoline, no unusual engine wear or carbon buildup and no problems of starting, vapor lock, or drivability. Additional research, by the University of Nebraska at Lincoln on the food value of the grain by-product of ethanol production, showed the following results: the extracted protein, called distillers dried grains, can be fed to human beings as well as livestock and actually have a net gain in protein greater than if the original whole grain had been fed directly to cattle.

In April 1978 the National Park Service and the District of Columbia Cooperative Extension Service sponsored an Energy Fair on the Washington Mall. Dr. Paul Middaugh of South Dakota State University demonstrated a two-column still, built by two of his graduate students. The still produced 192 proof ethyl alcohol at the rate of 22 gallons per hour. Dr. Middaugh took his still to Colby, Kansas, on May 19, 1978, for an Energy Day. From the response of May 19, in cooperation with a Colby manufacturing firm, a Nebraska minister, and Colby Community College, fuel alcohol workshops were begun at Colby Community College in July of 1979.

The response to the workshops was overwhelming. Farmers, bankers, businesspeople, legislators, and representatives of farm organizations from 35 states and several foreign countries met at Colby Community College with one common goal--Fuel Alcohol Production.

The State Fair Community College Agriculture Department staff held a meeting in April, 1979, to discuss renewable energy. Those in attendance included farmers, educators, and Missouri Division of Energy personnel. The enthusiastic response by the people attending this meeting led two staff members of the SFCC Ag Department to investigate Fuel Alcohol Production on the farm. After attending fuel alcohol meetings in Nebraska,

Iowa, and Kansas and interviewing farmers in Minnesota who were producing fuel alcohol, SFCC wrote a grant proposal to the Missouri Department of Natural Resources, Division of Energy, for funds to conduct a feasibility study to develop renewable energy systems on Missouri farms.

State Fair Community College staff members had attended the Fuel Alcohol Workshop at Colby Community College along with several area farmers. Upon their return, an Energy Advisory Committee was formed. This committee recommended that State Fair Community College develop a comprehensive education and demonstration program in the integration of renewable energy systems in Agriculture. The educational program when developed will consist of:

1. A new Two-Year Associate of Science Degree Program in Renewable Energy Resources and Applications in Agriculture.
2. Courses or units of instruction related to renewable energy applications offered in the existing post-secondary curriculum.
3. Unit of instruction related to renewable energy applications in the existing secondary vocational agriculture program.
4. A series of educational workshops, including such topics as: alcohol fuel production, methane gas production, solar applications, and soil conservation.
5. A series of special interest seminars for laypersons, users, and professional people.
6. Demonstrations of renewable energy systems applicable to agriculture.
7. The development and dissemination of individualized mediated instructional materials in renewable energy applications in agriculture.

8. The development and delivery of a community awareness and education program in renewable energy application in agriculture.

The State Fair Community College Board of Trustees has designated ten acres for the development of the renewable energy education and demonstration facility.

The education and demonstration renewable energy system will consist of a fuel alcohol still, a crop residue burner, a methane digester, and solar collectors, (Attachment A). The crop residue burner will provide the primary heat required for ethanol distillation. Solar collectors will be placed on the building housing the still to preheat water used for cooking the grain. Various grains, i.e., corn, grain, sorghum, and sugar cane will be used as feedstock for alcohol fuels production. Excess heat from the alcohol fuel process will be used to dry the distilled grain and heat a farrowing house and nursery. Solar collectors will also be used to dry the distilled grain. The distilled grain will be mixed with other feedstock to provide a balanced ration for the swine. The solid wastes from the swine unit will go through a methane digester. The biogas produced, along with solar collectors, will be used to aid in heating the farrowing house and nursery. The solid wastes from the digester will go into a two-stage lagoon to be returned to the soil as fertilizer. A standby electric generator, to be used during peak demands and/or power failure, may be powered by ethanol, or biogas.

The components utilized in the renewable energy system can be sized up or down depending on the needs of the individual farm unit. The system is designed to be an integrated system showing the relationship and application of the various forms of renewable energy on a farm setting.

On October 2, 1979, the College received word that it had been awarded a \$10,000 grant to conduct nine (9) alcohol fuel production workshops. The workshops were held during the summer of 1980. Goals of the workshops were:

1. To involve a minimum of 180 participants in the workshops and provide these individuals with the skills and knowledge necessary to implement alcohol fuel production in a farm setting.
2. To field-test and revise instructional materials in alcohol fuel production, which would be incorporated in secondary and post-secondary energy curricula at the college.
3. To develop, mediate, and distribute instructional materials in alcohol fuel production.
4. To expand the college's ability to offer a comprehensive educational program in renewable energy systems through the acquisition of additional hardware and instructional materials.

A grant was received from the Missouri Department of Natural Resources to develop two instructional modules on renewable energy resources and fuel alcohol production. The modules are available for distribution through the college's Media Center.

The Missouri Division of Community Development awarded a grant to the college to conduct a community awareness program in renewable energy resources. The goals of the community awareness program were:

1. Increase the awareness of 2,000 individuals of the energy dilemma and the application of renewable energy systems.
2. Inform those 2,000 individuals of the educational resources available through the renewable energy program at SFCC.
3. Involve at least 200 SFCC district residents in ongoing educational programs in renewable energy systems at the college.

4. Produce a 20-minute (professional quality) slide/tape presentation giving an overview of renewable energy application and make the presentation available for state and national distribution through the Media Center at SFCC.
5. Provide technical assistance to at least 20 area farm owners/operators to install a farm-size fuel alcohol production plant.

Renewable energy resources have been in existence for centuries and technology within the renewable areas is well developed. The advent of inexpensive fossil fuels has made renewable energy applications uneconomical until recent months. That, along with the realization of liquid and gaseous fossil fuel depletion by the turn of the century, has created a need for educational curriculum in these areas.

OBJECTIVES

1. Conduct a pilot study to ascertain employment opportunities being created in the emerging renewable energy resources and applications area of agriculture.
2. Compile a list of competencies required for the occupations identified.

SOLAR

An investigation by project personnel revealed that a number of studies had been conducted in the solar energy area. The most comprehensive of these studies was conducted by Batell, Columbus Laboratories in April 1980. The Batelle study shows clearly that employment opportunities for trained personnel will increase about 170% from 1978-1983. (Attachment B). The Batelle study also indicates that training for current employees in the solar energy field is needed. (Attachment C).

BIOMASS

SFCC formed an advisory panel to develop competencies and ascertain employment opportunities in the ag energy areas of fuel alcohol and methane gas production. The panel consisted of persons involved in renewable energy education, research, and manufacturing. (Attachment D)

The study developed by this panel consisted of 138 competencies in fuel alcohol production. A list of 202 potential employers in fuel alcohol production was developed from over 2400 names. The potential employers were asked to rate each competency and indicate the potential employment opportunities for trained personnel in their respective businesses. (Attachment E)

The response rate was very good and showed a need for 447 trained people by 1983. (Attachment F)

The energy area of methane gas production from livestock wastes is confined primarily to research at the present time. The equipment utilized in anaerobic bacterial digestion is almost entirely automated, so competencies consist of general knowledge and testing procedures rather than specific skills.

3. Design a two-year degree program in the application of renewable energy resources in agriculture.

Seven new courses have been identified for the "Ag Energy" Associate of Science Degree Program. The "Ag Energy" curriculum will be delivered through the SFCC Agriculture Department. Students in other areas of agriculture will have the opportunity to enroll in Ag Energy courses as electives. (Attachment G)

The structure of the Ag Energy curriculum was designed to mesh with three existing agriculture programs currently offered at SFCC.

Agri-Business, Farm Management, and Ag Mechanics students will have an opportunity to take the energy courses as electives.

Regardless of the field of agriculture students plan to enter, energy education is very critical to their success. Energy is a problem that will face American agriculture more and more in the future.

4. Prepare a final report summarizing (a) employment opportunities, (b) suggested curriculum, and (c) facilities and equipment needed to implement the program.

A. Employment Opportunities

Employment opportunities in ag energy are available today, especially in fuel alcohol production. SFCC recently contracted with Rural Missouri, Inc. to train seven people for employment in three fuel alcohol plants in Missouri. Rural Missouri, Inc. is the Department of Labor grantee in Missouri for administering the 303 program for seasonal and migrant farm workers.

The three plants in Missouri are located at Sikeston, Stockton and Monett. It is anticipated these plants will employ 5-10 people each and produce in excess of 2.0 million gallons of fuel grade alcohol per year.

A recent study by Oak Ridge Associated Universities is quoted in part:

Employment Potential

The fuel potential of ethanol has been known for years. It has not been widely used, however, because of the availability of inexpensive alternatives. As the price of petroleum based fuels rises, interest in the production and use of ethanol also rises. Blended with gasoline to produce gasohol, U.S. consumption of ethanol was between 80 and 90

million gallons in 1980.¹ Production levels close to 500 million gallons per year are expected by the end of 1981 and by the end of the decade 10 billion gallons per year may be produced.² Although sugar crops, agricultural residues, food processing wastes, municipal waste, wood, and other inputs are technically feasible, most fuel-grade ethanol production during the 1980s is likely to be derived from corn, milo, and wheat. If these grain feedstocks are obtained through increased production (a situation which becomes more likely the higher alcohol fuel production grows) the employment potential is enormous.

The potential for employment generated by the growth of a grain-to-ethanol industry is shown in Figure 4. The goal of 10 billion gallons per year is assumed to be reached in 1990, and corn is assumed to be the principal feedstock. Excluding the temporary construction jobs, permanent employment in the industry could reach as high as 174,000 workers. About 128,000 of these workers would be farm workers involved in the production and harvesting of corn. The use of milo or wheat would require even more farm workers. Twice as many in the case of milo and 2.5 times as many in the case of wheat. Depending on average plant size up to 46,000 might be employed in plant operations and transportation activities.

To the extent that grain-to-ethanol production dominates domestic alcohol fuel production, most of the related employment will be created in the grain growing states of the Midwest and the Great Plains. Sixteen states with over 20,000 square miles of cropland are identified in Figure 5. Even if new cropland is brought into cultivation for the

¹Office of Technology Assessment, Energy from Biological Processes, Report to congress, OTA-E-124, July 1980, p. 87

²U.S. Department of Energy, Office of Alcohol Fuels.

purpose of growing alcohol feedstock, these states stand to gain the most employment.

Alcohol Plant Operation and Maintenance. Current estimates suggest that to produce alcohol at an annual rate of 10 billion gallons per year by 1990 would require between 18,000 and 40,000 operation and maintenance workers.³ The higher number would prevail if small plants, under 10 million gallons per year, predominate. The lower number would prevail if large plants, 50 million gallons or more per year, predominate. In any case, a fairly wide range of occupations and skills will be necessary. Table 7 gives typical staffing patterns for plants of various sizes.⁴ While a significant number of unskilled shipping clerks, warehouse workers, grain handlers and other laborers might be employed, an even larger number of skilled and semi-skilled workers will be required. Included in this group are boiler and equipment operators, laboratory workers, maintenance crews, and administrative workers.

Well defined credentials, licenses, certificates or degrees are required for many of the skilled workers in an alcohol fuel plant. As discussed in the previous section in conjunction with the fuelwood cycle, boiler operators may need to be licensed after acquiring considerable on-the-job training and formal instruction. Clerical workers are required to have learned basic office and secretarial skills. Maintenance workers may be required to have completed apprenticeship training in their craft. Even sales workers, managers and administrative personnel may have some formal education or experience criteria which must be

³ Oak Ridge Associated Universities, Some Employment and Earnings Implications of Regional Biomass Energy Utilization: New England and the Cornbelt, report to Solar Strategy, Analysis, and Integration, CSE/DOE, 1981.

⁴ Because few actual plants exist, these figures are based largely on engineering designs and feasibility studies.

satisfied. In all of these cases, however, the occupations and basic skills are not unique to the alcohol industry. Well established programs exist with time honored curriculum designed to give individuals the necessary background for these positions. The growth of an alcohol fuels industry, regardless of the rate of growth, is unlikely to overburden existing programs training workers in these categories.

Regardless of the general nature of the work performed by most alcohol plant workers, there are some who must be fairly specifically trained. Process operators, chemists, and laboratory technicians all fall into this category. Collectively they have responsibility for monitoring the entire production process of the plant. Their responsibilities include control of temperatures, volume, chemical and enzyme levels, processing time, and a variety of other production activities. While many of these specific skills and techniques can be learned on the job, some general background is helpful in the case of process operators and is necessary in the case of chemists and laboratory technicians.

Chemists generally receive formal training in a post-secondary institution. For all but the largest commercial alcohol plants, a four-year college degree in chemistry is sufficient background. For plants producing 50 million or more gallons per year, at least one chemist with some graduate level work in chemistry or chemical engineering may be required. Laboratory technicians, who typically assist the chemist in monitoring and testing, will generally have completed a two-year degree program or have some previous laboratory experience.

Most colleges, universities and two-year colleges have well-established programs to train chemists or laboratory technicians. All major universities and most four-year colleges offer degrees in chemistry, and

approximately 125 technical schools offer training for chemical technicians.⁵ The demand for chemists, chemical engineers, and laboratory technicians is expected to grow at about the same rate as other occupations.⁶ Unless this situation changes, the supply of chemists and laboratory workers to the alcohol fuel industry ought to be adequate.

The training and certification requirements for alcohol fuel plant process operators has yet to be established. A variety of workshops, short courses, and technical school programs have begun to emerge to satisfy this need. The Department of Energy, through the Office of Conservation and Solar Energy, has funded 40 institutions with \$10,000 to develop alcohol fuel programs. Most have served primarily as awareness programs to provide general information to farmers, the public and potential small alcohol plant operators. Some have provided for some skill training but have been limited to relatively short, 3 to 5 day, programs. A listing of the institutions receiving DOE funds for alcohol fuel curriculum development is included in the appendix to this report.

The National Gasohol Commission and the American Association of Community and Junior Colleges have also worked together to organize and sponsor workshops. Most have been designed for two-year college faculty interested in initiating alcohol fuel programs. The workshops serve as forums for the discussion of approaches to training and provide a response to alcohol industry proponents who support the permanent alcohol technician programs. The most likely outcome appears to be the integration of special alcohol-related courses into existing programs.

⁵ Barron's Guide to Two-year Colleges, Vol. II, Occupational Program Selector, Barron's Educational Services, Woodbury, New York, 1979.

⁶ Bureau of Labor Statistics, Occupational Outlook Handbook, 1980-81 Edition, U.S. Department of Labor, 1980.

Another study completed by Employment Research Associates of Lansing, MI concluded that 71,000 people would be required on a permanent basis to operate, maintain and supply the fuel alcohol plants producing 6.0 billion gallons per year. This averages about five direct jobs per million gallons of alcohol produced. (Attachment H)

B. Suggested Curriculum

It was the consensus of opinion among the Advisory Panel, SFCC Project Personnel, the National Gasohol Commission, and the American Association of Junior and Community Colleges Energy Communications Center that energy curriculum should involve several disciplines within the educational institution. (Attachment I)

The Ag Energy curriculum consists of seven core courses taught in four separate departments within the college.

- | | | |
|----|--|---------|
| 1. | Intro to Ag Energy | 3 hours |
| | Agriculture Department | |
| 2. | Chemistry of Energy Processes | 3 hours |
| | Chemistry Department | |
| 3. | Introductory Agricultural Biology | 3 hours |
| | Biology Department | |
| 4. | Alcohol Fuels I | 3 hours |
| | Agriculture Department | |
| 5. | Alcohol Fuels II | 5 hours |
| | Agriculture Department | |
| 6. | Ag Energy Production | 3 hours |
| | Agriculture Department | |
| 7. | Solar Energy: Theory and Applications | 3 hours |
| | Mid-management Department | |
| | Building Materials Merchandising Program | |

In addition to the core energy courses, students will complete the following:

General education	20 hours
General Agriculture	13 hours
Electives	6 hours
Occupational Internship	16 hours

C. Facilities and Equipment

At the present time, SFCC is the only community college in Missouri involved in the development of a comprehensive Ag Energy program. The College has obtained funding from various State and Federal agencies for equipment and facilities. A 40' x 75' building has been constructed complete with classroom, restrooms, and a fuel alcohol distillation unit capable of producing 600 gallons of fuel-grade alcohol per week. The classroom will be equipped with lab tables and equipment necessary for instruction, as well as quality control in the fuel alcohol production. A large bale burner is being built with funds from the U.S. Department of Energy to provide a renewable source of energy for the building and the fuel alcohol process.

In May of 1981, SFCC received \$6,000 worth of solar training equipment from the Lennox Corporation. Plans are underway to establish a solar lab for instructional purposes.

It should be noted that SFCC has chosen to build and equip a pilot production alcohol plant with future plans to build a production livestock unit and methane digester. These facilities and equipment will be used for hands on experience and training. (Attachment J)

The Ag Energy curriculum could be delivered in a traditional classroom setting with small lab top models of a distillation system and a

methane digester. A small flat plate collector can be built or purchased for a visual aid in the solar course.

The lab distillation equipment can be purchased from many laboratory supply companies at a nominal cost. The marketing representative of the company can assist in the selection of equipment.

5. Implement a two-year degree program in renewable energy resources and applications in agriculture.

In May of 1981, SFCC received approval from the Missouri Coordinating Board of Higher Education to offer a two-year degree program in "Ag Energy." The degree program will begin fall semester 1981, with the first graduates expected in May 1983.

6. Develop and distribute mediated instructional materials in renewable energy through the college's Media Center.

The State Fair Community College Media Center is well established with a current listing of 40 Health Occupations, 18 Welding, 19 Agriculture, 51 Business and Office, 9 Pre-Employment, 1 Alcohol Fuels, and 8 Sex Equity instructional modules which are available for distribution to educational institutions.

Instructional materials are disseminated on an individual sale and total program field-test basis. Over 330 modules were disseminated during the past year on an individual basis. In the Business and Office area 21 Missouri institutions are utilizing the total curriculum package which includes 6 complete courses and over 50 modules. Four institutions are utilizing the total welding curriculum on a field-test basis.

The materials developed through this project will serve as a foundation for future curriculum development by the Media Center.

Population and Sample

Employer survey mailing lists were selected from participants of renewable energy seminars held at various educational institutions in Kansas, Nebraska, Iowa, Illinois, and Missouri; membership lists of nonprofit organizations including National Alcohol Fuel Producers Association, National Gasohol Commission, Renewable Energy LTD, National Center for Appropriate Technology, Missouri Fuel Alcohol Commission; and the commercial alcohol industry.

Consultants for this project were selected from educational institutions, agri-business, federal and state energy agencies, and professional engineering firms who are actively engaged in renewable energy research and application of renewable energy technology.

These recognized experts assisted the college staff with (1) the identification of occupations that are currently emerging in this new industry, (2) the identification of competencies that should be taught in a two-year technical program in renewable energy applications in agriculture, and (3) the identification of the facilities and equipment that would be needed to implement the instructional program and accomplish the other major project goals.

CONCLUSIONS AND RECOMMENDATIONS

1. Employment Opportunities

The need for specialized training is present in the fuel alcohol industry now, with expectations of greater need in the next five year.

The solar industry will require a training period for installation and maintenance people. These people will probably be employed in the heating and cooling trades and the plumbing trade.

2. Availability of Training Programs

A general agricultural energy educational program is not available. SFCC is the only educational institution pursuing this course of action, that we are aware of at this time. Several institutions have solar programs, and a few have specialized fuel alcohol programs.

3. Recommendations

Because of the tremendous cost involved, it is not recommended that every educational institution build a renewable energy farm. But instead, implement specific energy courses into existing curriculum utilizing existing faculty in various disciplines.

Agriculture faces the responsibility of feeding this country and large portions of the world. Although production agriculture uses only 3% of the total energy consumed in the U.S., a dependable supply is absolutely necessary to insure the production of food and fiber.

Education of the agricultural sector is essential. Tremendous supplies of energy are produced annually by farmers in the U.S. These energy sources must be used to eliminate the uncertainty of supply

and price of fuel needed for production agriculture.

The price of energy has been a bargain in the past, and it is a bargain today compared to what it will be in the near future.

Energy education should be implemented into the educational system K through 12. The students in these grades must be knowledgeable about energy because they will be faced with the prospect of living through a continual "Energy Crisis."

Disclaimer

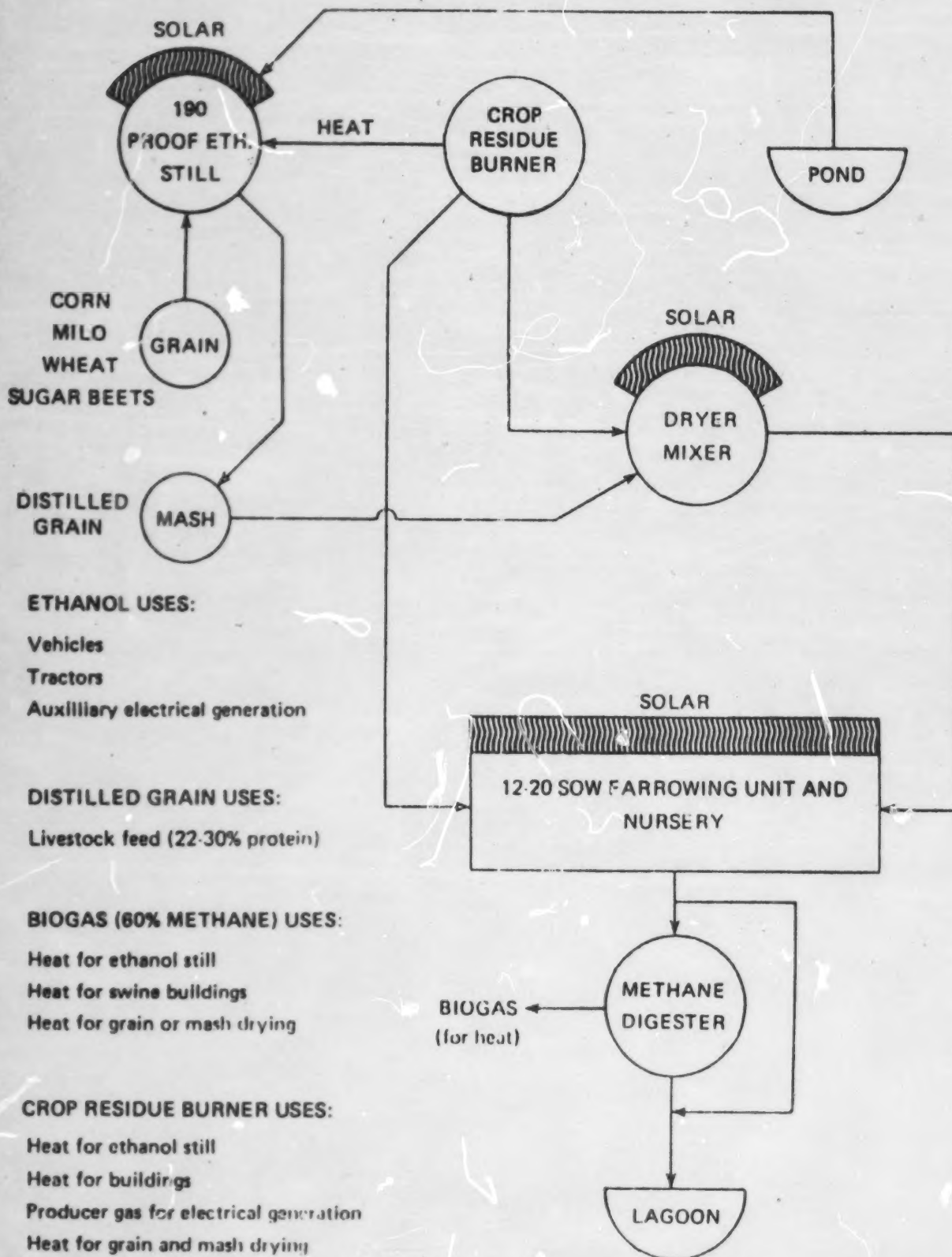
"The activity which is the subject of this report was supported in whole or in part by funds from the Department of Elementary and Secondary Education, Division of Career and Adult Education. However, the opinions expressed herein do not necessarily reflect the position or policies of the Missouri Department of Elementary and Secondary Education or the Division of Career and Adult Education, and no official endorsement should be inferred."

ATTACHMENTS

ATTACHMENT A

FARM-SIZE RENEWABLE ENERGY SYSTEM

FARM-SIZE RENEWABLE ENERGY SYSTEM



ATTACHMENT B

TABLE 34. BATELLE STUDY

Table 34. PROJECTED CHANGES IN FULL-TIME EQUIVALENT SOLAR EMPLOYMENT, 1978

Activity	FTE Employment 1978	FTE Employment 1981	Percentage Change 1978 - 1981	FTE Employment 1983	Percentage Change 1978 - 1983
R&D	9,111	15,852	74.0	22,245	144.2
Commercial	7,296	17,282 *	136.9	22,120 *	203.2
Total	16,407	33,134	102.0	44,365	170.4

*Based on recent trends.

ATTACHMENT C

TABLE 30. BATELLE STUDY

***Table 30. ADDITIONAL EDUCATION AND TRAINING NEEDED BY EMPLOYEES
BY CURRENT OCCUPATION, 1978
(PERCENT OF RESPONDENTS)**

Skill and Knowledge Area	Technicians (N-20)	Skilled Crafts (N-20)
Knowledge of solar energy applications, technology and market	10.0	25.0
Analysis, design and evaluation of systems	50.0	20.0
Management	20.0	20.0
Communication and research skills, miscellaneous abilities and formalized training	10.0	5.0

* The above represents a portion of Table 30.

ATTACHMENT D

STATE FAIR COMMUNITY COLLEGE
ADVISORY PANEL

STATE FAIR COMMUNITY COLLEGE "ADVISORY PANEL"

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Oak Ridge Associated Universities

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ATTACHMENT E

COMPETENCIES QUESTIONNAIRE

BEFORE YOU BEGIN THE QUESTIONNAIRE, IT WILL BE APPRECIATED IF YOU WILL SUPPLY THE FOLLOWING GENERAL INFORMATION:

Which of the following best describes your involvement in the Fuel Alcohol Industry?

- ☐ PRODUCER
- ☐ EQUIPMENT MANUFACTURER
- ☐ EDUCATOR
- ☐ OTHER _____

IF YOU ARE A PRODUCER, PLEASE COMPLETE THE REST OF THE INFORMATION.

I am now producing fuel alcohol.

Plant size _____ (Gallons per year)

I plan to produce fuel alcohol in the near future.

Plant size _____ (Gallons per year)

I plan to operate the plant myself.

Yes _____

No _____

I plan to hire trained personnel to operate the plant in the future.

Yes _____

No _____

I anticipate the following number of jobs will be available in my plant during:

1981 _____

1982 _____

1983 _____

I would be interested in interviewing someone with a Two-year Associate Degree in Agricultural Energy in 1983.

Yes _____

No _____

D I R E C T I O N S

The Questionnaire contains 138 skills and areas of knowledge identified by our panel. Place an (X) under the degree of importance you place on each skill or area of knowledge. Rank each competency as if you were hiring a person to operate your fuel alcohol plant. It should take about 20 minutes to complete the Questionnaire.

We have attempted to be inclusive of a fuel alcohol plant from start to finish. IF THERE ARE AREAS WE HAVE OVERLOOKED THAT YOU FEEL ARE IMPORTANT, PLEASE ADD THEM ON THE REVERSE SIDE OF THE QUESTIONNAIRE AND PLACE AN (X) TO DESIGNATE THE DEGREE OF IMPORTANCE.

REQUIRED: When the beginning employee must have a thorough working knowledge and be able to perform with the accuracy and speed of a competent employee.

USEFUL: When the competency is not of a direct consequence for the job, but the beginning worker should be familiar with it.

NOT NEEDED: When the knowledge or skill is not required to perform the job.

QUESTIONNAIRE

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT NEEDED

SAMPLE:

- | | | | |
|---|-------------------------------------|-------------------------------------|--------------------------|
| 1. Be able to complete accurately a scale ticket. | ☒ | ☐ | ☐ |
| 2. Be able to identify alphatoxin in grain. | ☐ | ☒ | ☐ |

FEEDSTOCK PURCHASING AND STORAGE

- | | | | |
|---|--------------------------|--------------------------|--------------------------|
| 1. Be able to draw a representative sample of grain from truck, wagon or railcar. | ☐ | ☐ | ☐ |
| 2. Be able to measure the weight per bushel of a grain sample. | ☐ | ☐ | ☐ |
| 3. Be able to measure the foreign material content of a grain sample. | ☐ | ☐ | ☐ |
| 4. Be able to determine the moisture content of a grain sample. | ☐ | ☐ | ☐ |
| 5. Be able to correctly weigh a grain carrier. | ☐ | ☐ | ☐ |
| 6. Be able to complete accurately a scale ticket. | ☐ | ☐ | ☐ |
| 7. Be able to compute the net bushels and value of grain. | ☐ | ☐ | ☐ |
| 8. Be able to identify alphatoxin in grain. | ☐ | ☐ | ☐ |
| 9. Be able to operate grain handling machines and equipment. | ☐ | ☐ | ☐ |
| 10. Be able to determine when and how to dry and condition grain. | ☐ | ☐ | ☐ |
| 11. Be able to operate grain aeration, drying and turning equipment. | ☐ | ☐ | ☐ |
| 12. Be able to identify insects and diseases in stored grain. | ☐ | ☐ | ☐ |
| 13. Be able to effectively treat grain for insects and diseases. | ☐ | ☐ | ☐ |
| 14. Be able to locate and alleviate "hot spots" in stored grain. | ☐ | ☐ | ☐ |
| 15. Be able to comply with government regulations, i.e., OSHA and EPA regarding grain handling and storage. | ☐ | ☐ | ☐ |
| 16. Be familiar with storage procedures for feedstocks other than grain, i.e., tubers, cane. | ☐ | ☐ | ☐ |

(O V E R)

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT

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QUESTIONNAIRE

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT NEEDED

FEEDSTOCK PREPARATION

- | | | | |
|--|--------------------------|--------------------------|--------------------------|
| 1. Be able to operate grain grinding and rolling equipment. | ☐ | ☐ | ☐ |
| 2. Be able to check ground or rolled grain for fineness (sieves or screens). | ☐ | ☐ | ☐ |
| 3. Be able to measure the weight of ground or rolled grain. | ☐ | ☐ | ☐ |
| 4. Be familiar with equipment used in processing feedstocks other than grain, i.e., potatoes, beets, cane etc. | ☐ | ☐ | ☐ |

(O V E R)

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT

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QUESTIONNAIRE

REQUIRED

USEFUL

NOT NEEDED

SKILL OR KNOWLEDGE

MASHING (LIQUEFACTION AND SACCHARIFICATION)

- | | | | |
|--|--------------------------|--------------------------|--------------------------|
| 1. Be able to calibrate and adjust a pH meter. | ☐ | ☐ | ☐ |
| 2. Be able to use a pH meter and interpret the reading. | ☐ | ☐ | ☐ |
| 3. Be able to adjust the pH of a solution by adding an acid or base. | ☐ | ☐ | ☐ |
| 4. Be able to perform a starch conversion test. | ☐ | ☐ | ☐ |
| 5. Be able to calculate the dry starch present in a feedstock sample. | ☐ | ☐ | ☐ |
| 6. Be able to calculate the sugar present in a feedstock sample. | ☐ | ☐ | ☐ |
| 7. Be able to read a thermometer or temperature gauge. | ☐ | ☐ | ☐ |
| 8. Be able to calibrate a temperature gauge. | ☐ | ☐ | ☐ |
| 9. Be able to convert fahrenheit to celsius and vice versa. | ☐ | ☐ | ☐ |
| 10. Be able to read and follow label directions from enzyme suppliers. | ☐ | ☐ | ☐ |
| 11. Be able to calculate the quantity of enzyme needed based on dry starch available in feedstock. | ☐ | ☐ | ☐ |
| 12. Be able to maintain mash at proper temperature and pH according to recommendations of enzyme manufacturer. | ☐ | ☐ | ☐ |
| 13. Be able to operate materials handling equipment, i.e., pumps, motors, valves etc. | ☐ | ☐ | ☐ |
| 14. Be able to institute and maintain high degree of hygiene in pumps, pipes, mashing vessels etc. | ☐ | ☐ | ☐ |
| 15. Be able to institute and maintain high degree of hygiene in the distillation building. | ☐ | ☐ | ☐ |
| 16. Be able to sterilize equipment. | ☐ | ☐ | ☐ |
| 17. Be able to measure percent sugar in a solution. | ☐ | ☐ | ☐ |
| 18. Be able to read and interpret a Brix hydrometer. | ☐ | ☐ | ☐ |
| 19. Be able to calculate volume percentages to adjust percent sugar in a solution. | ☐ | ☐ | ☐ |
| 20. Be able to interpret the results of a water sample laboratory analysis. | ☐ | ☐ | ☐ |
| 21. Be able to calculate the amount of grain and water for desirable mixture. | ☐ | ☐ | ☐ |

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT N

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11.	☐	☐	☐
12.	☐	☐	☐

Q U E S T I O N N A I R E

REQUIRED

USEFUL

NOT NEEDED

SKILL OR KNOWLEDGE

MASHING (LIQUEFACTION AND SACCHARIFICATION) continued

- | | | | |
|--|--------------------------|--------------------------|--------------------------|
| 22. Be able to calculate the amount of acid or base needed to adjust pH. | ☐ | ☐ | ☐ |
| 23. Be able to weigh samples on a triple beam balance. | ☐ | ☐ | ☐ |
| 24. Be able to "zero" a balance for accurate readings. | ☐ | ☐ | ☐ |
| 25. Be able to convert grams to pounds and vice versa. | ☐ | ☐ | ☐ |

(O V E R)

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT NEEDED

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12.	☐	☐	☐

Q U E S T I O N N A I R E

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT NEEDED

FERMENTATION

- | | | | |
|--|--------------------------|--------------------------|--------------------------|
| 1. Be able to institute and maintain high degree of hygiene in fermenters, pumps, motors, valves, piping etc. | ☐ | ☐ | ☐ |
| 2. Be able to read and interpret label instructions from commercial yeast suppliers. | ☐ | ☐ | ☐ |
| 3. Be able to culture a yeast inoculum. | ☐ | ☐ | ☐ |
| 4. Be able to count yeast population through a microscope. | ☐ | ☐ | ☐ |
| 5. Be able to effectively use a microscope. | ☐ | ☐ | ☐ |
| 6. Be able to adjust and maintain proper temperature in fermenter. | ☐ | ☐ | ☐ |
| 7. Be able to adjust and maintain proper pH in fermenter. | ☐ | ☐ | ☐ |
| 8. Be able to measure volume of yeast for proper inoculation. | ☐ | ☐ | ☐ |
| 9. Be able to purge fermenters of CO ₂ before cleaning and sterilization. | ☐ | ☐ | ☐ |
| 10. Be able to install and maintain venting apparatus on fermenters. | ☐ | ☐ | ☐ |
| 11. Be able to test for alcohol content in fermenters. | ☐ | ☐ | ☐ |
| 12. Be able to initiate and follow testing procedures during fermentation, i.e., pH, alcohol content, sugar content. | ☐ | ☐ | ☐ |
| 13. Be able to properly use laboratory distillation equipment. | ☐ | ☐ | ☐ |
| 14. Be able to operate and control agitation during fermentation. | ☐ | ☐ | ☐ |

(O V E R)

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

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QUESTIONNAIRE

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT NEEDED

DISTILLATION

- | | | | |
|---|--------------------------|-------------------------------------|-------------------------------------|
| 1. Be able to read and interpret an alcohol hydrometer. | ☐ | ☒ | ☐ |
| 2. Be able to read and interpret a specific gravity hydrometer. | ☐ | ☐ | ☐ |
| 3. Be able to adjust temperature of solutions for accurate readings from hydrometers. | ☐ | ☐ | ☐ |
| 4. Be able to calibrate, utilize and interpret readings from a balance and pycnometer. | ☐ | ☐ | ☐ |
| 5. Be able to test stillage for alcohol content. | ☐ | ☐ | ☐ |
| 6. Be able to test stillage for moisture content. | ☐ | ☐ | ☒ |
| 7. Be able to adjust steam control valves for temperature control. | ☐ | ☐ | ☐ |
| 8. Be able to adjust beer flow control valves for temperature control. | ☐ | ☐ | ☐ |
| 9. Be able to adjust reflux control valves for temperature control. | ☐ | ☐ | ☐ |
| 10. Be able to convert gallons to proof gallons. | ☐ | ☐ | ☐ |
| 11. Be able to maintain adequate records of alcohol production and disposition for the BATF and State agencies. | ☐ | ☐ | ☐ |
| 12. Be able to calculate amounts of denaturant required by the BATF. | ☐ | ☐ | ☐ |
| 13. Be able to accurately complete reports to the BATF and State agencies. | ☐ | ☐ | ☐ |
| 14. Be able to properly clean an alcohol spill in the plant. | ☐ | ☐ | ☐ |
| 15. Be able to describe the function and basic theory of dehydrating alcohol by various methods, i.e., desiccant, ternary, molecular sieve. | ☐ | ☐ | ☐ |
| 16. Be able to explain the chemical and physical properties of alcohol regarding safety. | ☐ | ☐ | ☐ |

(O V E R)

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

REQUIRED

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QUESTIONNAIRE

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT NEEDED

ALCOHOL STORAGE AND HANDLING

- | | | | |
|---|--------------------------|--------------------------|--------------------------|
| 1. Be able to identify storage tank materials that are compatible with alcohol. | ☐ | ☐ | ☐ |
| 2. Be able to identify pump components that are compatible with alcohol. | ☐ | ☐ | ☐ |
| 3. Be able to properly vent alcohol storage tanks. | ☐ | ☐ | ☐ |
| 4. Be able to operate alcohol storage and pumping equipment. | ☐ | ☐ | ☐ |
| 5. Be able to test alcohol for proof and acidity. | ☐ | ☐ | ☐ |

(O V E R)

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT NEEDED

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11.	☐	☐	☐
12.	☐	☐	☐

Q U E S T I O N N A I R E

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT NEEDED

STILLAGE STORAGE AND HANDLING

- | | | | |
|---|--------------------------|--------------------------|--------------------------|
| 1. Be able to operate a stillage separator and dewatering press. | ☐ | ☐ | ☐ |
| 2. Be able to identify proper disposal methods of thin stillage. | ☐ | ☐ | ☐ |
| 3. Be able to take a moisture sample of distillers grains. | ☐ | ☐ | ☐ |
| 4. Be able to perform a crude protein analysis of distillers grains. | ☐ | ☐ | ☐ |
| 5. Be able to formulate a balanced ration for different species of livestock using distillers grains. | ☐ | ☐ | ☐ |
| 6. Be able to calculate dry basis for wet stillage. | ☐ | ☐ | ☐ |
| 7. Be able to calculate price using either wet or dry stillage basis. | ☐ | ☐ | ☐ |
| 8. Be able to detect spoilage in wet distillers grains. | ☐ | ☐ | ☐ |
| 9. Be able to properly dispose of spoiled distillers grains. | ☐ | ☐ | ☐ |

(O V E R)

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

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8.	☐	☐	☐
9.	☐	☐	☐
10.	☐	☐	☐
11.	☐	☐	☐
12.	☐	☐	☐

Q U E S T I O N N A I R E

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT NEEDED

EQUIPMENT AND BUILDING

- | | | | |
|---|--------------------------|--------------------------|--------------------------|
| 1. Be able to identify different types of valves, i.e., gate, ball, globe, needle etc. | ☐ | ☐ | ☐ |
| 2. Be able to identify different types of pipe, i.e., galvanized, black, PVC, CPVC etc. | ☐ | ☐ | ☐ |
| 3. Be able to properly size pipe and valves for liquids, compressed air and fluids. | ☐ | ☐ | ☐ |
| 4. Be able to select proper type of pipe for specific purpose according to need and pipe manufacturer's specifications. | ☐ | ☐ | ☐ |
| 5. Be able to service boiler water treatment equipment. | ☐ | ☐ | ☐ |
| 6. Be able to read and interpret pressure gauges for water, air and fluids. | ☐ | ☐ | ☐ |
| 7. Be able to calculate temperatures from pressure readings. | ☐ | ☐ | ☐ |
| 8. Be able to identify different types of steam traps, i.e., float, thermostatic etc. | ☐ | ☐ | ☐ |
| 9. Be able to size steam traps to steam systems. | ☐ | ☐ | ☐ |
| 10. Be able to calculate heat loss from exposed pipes, vessels and building. | ☐ | ☐ | ☐ |
| 11. Be able to determine insulating values of insulation and other building materials. | ☐ | ☐ | ☐ |
| 12. Be able to interpret fire ratings of various materials used in construction and insulation. | ☐ | ☐ | ☐ |
| 13. Be able to identify different types of pumps, i.e., centrifugal, diaphragm, vacuum etc. | ☐ | ☐ | ☐ |
| 14. Be able to select proper type pump for specific purpose according to need and manufacturer's specifications. | ☐ | ☐ | ☐ |
| 15. Be able to identify different types of motors, i.e., electric, air, fluid etc. | ☐ | ☐ | ☐ |
| 16. Be able to select proper type motor for specific purpose according to need and manufacturer's specifications. | ☐ | ☐ | ☐ |

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT

1.	☐	☐	☐
2.	☐	☐	☐
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12.	☐	☐	☐

QUESTIONNAIRE

SKILL OR KNOWLEDGE

REQUIRED
USEFUL
NOT NEEDED

MAINTENANCE AND MINOR REPAIR OF EQUIPMENT

1. Be able to follow service manual recommendations and perform preventative maintenance on the following equipment:

- | | | | |
|--------------------------------|--------------------------|--------------------------|--------------------------|
| A. Grain Grinders | ☐ | ☐ | ☐ |
| B. Grain Rollers | ☐ | ☐ | ☐ |
| C. Grain Augers and Elevators | ☐ | ☐ | ☐ |
| D. Grain Fans and Dryers | ☐ | ☐ | ☐ |
| E. Steam Boilers | ☐ | ☐ | ☐ |
| F. Air Compressors | ☐ | ☐ | ☐ |
| G. Hydraulic Systems | ☐ | ☐ | ☐ |
| H. Material Handling Equipment | | | |
| a. Pumps | ☐ | ☐ | ☐ |
| b. Motors | ☐ | ☐ | ☐ |
| c. Valves | ☐ | ☐ | ☐ |
| d. Pipe | ☐ | ☐ | ☐ |
| I. Stillage Separator | ☐ | ☐ | ☐ |
| J. Dewatering Press | ☐ | ☐ | ☐ |
| K. Stillage Dryer | ☐ | ☐ | ☐ |

2. Be able to keep maintenance records on all equipment.

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(O V E R)

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT NEEDED

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Q U E S T I O N N A I R E

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT NEEDED

SAFETY

1. Be able to recognize unsafe conditions in the following areas:

- | | | | |
|------------------------------------|--------------------------|--------------------------|--------------------------|
| A. Feedstock Preparation Equipment | ☐ | ☐ | ☐ |
| B. Grain Moving Equipment | ☐ | ☐ | ☐ |
| C. Boiler Operations | ☐ | ☐ | ☐ |
| D. Enzyme Storage and Handling | ☐ | ☐ | ☐ |
| E. Acid Storage and Handling | ☐ | ☐ | ☐ |
| F. Venting of CO ₂ | ☐ | ☐ | ☐ |
| G. Distillation Procedures | ☐ | ☐ | ☐ |
| H. Alcohol Storage and Handling | ☐ | ☐ | ☐ |
| I. Stillage Separation Equipment | ☐ | ☐ | ☐ |
| J. Stillage Drying Equipment | ☐ | ☐ | ☐ |
| K. Stillage Storage | ☐ | ☐ | ☐ |
| L. Denaturant Storage and Handling | ☐ | ☐ | ☐ |

- | | | | |
|---|--------------------------|--------------------------|--------------------------|
| 2. Be able to install and maintain safety shields on all equipment. | ☐ | ☐ | ☐ |
| 3. Be able to select proper firefighting equipment for an alcohol fire. | ☐ | ☐ | ☐ |
| 4. Be able to correctly use firefighting equipment on an alcohol fire. | ☐ | ☐ | ☐ |
| 5. Be able to administer CPR (Cardio-Pulmonary Resuscitation). | ☐ | ☐ | ☐ |
| 6. Be able to administer basic first aid. | ☐ | ☐ | ☐ |
| 7. Be able to maintain safety records on personnel. | ☐ | ☐ | ☐ |

(O V E R)

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

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ATTACHMENT F

SUMMARY OF EMPLOYMENT SURVEY
AND
COMPETENCIES QUESTIONNAIRE

RESPONSES RECEIVED:

51 - Tabulated (January 23, 1981)

19 - Either were not usable or received after
tabulation

—
70 Total Received

Total Questionnaires Sent - 202

Percentage of Response - 34.653%

OF THE 51 TABULATED:

18 - Indicated Jobs Would Be Available

15 - Would like to interview 1983 Graduates

3 - Would not want to interview 1983 Graduates

OF THE 18 INDICATING JOBS AVAILABLE:

11 - Indicated a total of 447 jobs

7 - Indicated jobs would be available, but did
not give specifics

AVAILABILITY OF THE 447 JOBS WAS INDICATED:

52 - 1981

141 - 1982

254 - 1983

QUESTIONNAIRE

NO RESPONSE
NOT NEEDED
USEFUL
REQUIRED

SKILL OR KNOWLEDGE

5 3 1 0

SAMPLE:

1. Be able to complete accurately a scale ticket.
2. Be able to identify alphatoxin in grain.

FEEDSTOCK PURCHASING AND STORAGE

- | | |
|---|---------|
| 1. Be able to draw a representative sample of grain from truck, wagon or railcar. | 4.13461 |
| 2. Be able to measure the weight per bushel of a grain sample. | 4.17308 |
| 3. Be able to measure the foreign material content of a grain sample. | 4.09615 |
| 4. Be able to determine the moisture content of a grain sample. | 4.25 |
| 5. Be able to correctly weigh a grain carrier. | 4.09615 |
| 6. Be able to complete accurately a scale ticket. | 4.13461 |
| 7. Be able to compute the net bushels and value of grain. | 4.17308 |
| 8. Be able to identify alphatoxin in grain. | 3.25 |
| 9. Be able to operate grain handling machines and equipment. | 4.32692 |
| 10. Be able to determine when and how to dry and condition grain. | 3.75 |
| 11. Be able to operate grain aeration, drying and turning equipment. | 4.21154 |
| 12. Be able to identify insects and diseases in stored grain. | 3.44231 |
| 13. Be able to effectively treat grain for insects and diseases. | 3.48077 |
| 14. Be able to locate and alleviate "hot spots" in stored grain. | 3.78846 |
| 15. Be able to comply with government regulations, i.e., OSHA and EPA regarding grain handling and storage. | 3.98077 |
| 16. Be familiar with storage procedures for feedstocks other than grain, i.e., tubers, cane. | 3. |

(O V E R)

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT NEEDED

1. CAPABLE OF RUNNING COMBINE OR POTATO HARVESTER

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Q U E S T I O N N A I R E

NO RESPONSE
NOT NEEDED
USEFUL
REQUIRED

SKILL OR KNOWLEDGE

FEEDSTOCK PREPARATION

- | | |
|--|---------|
| 1. Be able to operate grain grinding and rolling equipment. | 4.29412 |
| 2. Be able to check ground or rolled grain for fineness (sieves or screens). | 4.29412 |
| 3. Be able to measure the weight of ground or rolled grain. | 4.21569 |
| 4. Be familiar with equipment used in processing feedstocks other than grain, i.e., potatoes, beets, cane etc. | 2.78431 |

(O V E R)

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT

1.	JERUSALEM ARTICHOKE APPEAR TO BE ONE OF OUR MOST PROMISING FEEDSTOCKS. OUT STUDENTS MAY BE INVOLVED IN SUPERVISING THEIR PRODUCTION	☐	☒	☐
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Q U E S T I O N N A I R E

NO RESPONSE
NOT NEEDED
USEFUL
REQUIRED

SKILL OR KNOWLEDGE

MASHING (LIQUEFACTION AND SACCHARIFICATION)

5 3 1 0

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|--|---------|
| 1. Be able to calibrate and adjust a pH meter. | 4.41177 |
| 2. Be able to use a pH meter and interpret the reading. | 4.64706 |
| 3. Be able to adjust the pH of a solution by adding an acid or base. | 4.64706 |
| 4. Be able to perform a starch conversion test. | 4.4902 |
| 5. Be able to calculate the dry starch present in a feedstock sample. | 4.17647 |
| 6. Be able to calculate the sugar present in a feedstock sample. | 4.13725 |
| 7. Be able to read a thermometer or temperature gauge. | 4.68627 |
| 8. Be able to calibrate a temperature gauge. | 4.21569 |
| 9. Be able to convert fahrenheit to celsius and vice versa. | 3.98039 |
| 10. Be able to read and follow label directions from enzyme suppliers. | 4.60784 |
| 11. Be able to calculate the quantity of enzyme needed based on dry starch available in feedstock. | 4.4902 |
| 12. Be able to maintain mash at proper temperature and pH according to recommendations of enzyme manufacturer. | 4.68627 |
| 13. Be able to operate materials handling equipment, i.e., pumps, motors, valves etc. | 4.52941 |
| 14. Be able to institute and maintain high degree of hygiene in pumps, pipes, mashing vessels etc. | 4.56863 |
| 15. Be able to institute and maintain high degree of hygiene in the distillation building. | 4.41177 |
| 16. Be able to sterilize equipment. | 4.56863 |
| 17. Be able to measure percent sugar in a solution. | 4.47059 |
| 18. Be able to read and interpret a Brix hydrometer.
WHY BRIX & NOT SP.G., looks like "PLATS", BALLING? | 4.43137 |
| 19. Be able to calculate volume percentages to adjust percent sugar in a solution. | 4.2549 |
| 20. Be able to interpret the results of a water sample laboratory analysis. | 3.86275 |
| 21. Be able to calculate the amount of grain and water for desirable mixture. | 4.60784 |

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT

1. USE TOP-LOADING AUTOMATIC BALANCE

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2. BE FAMILIAR WITH ENZYME STRUCTURE; MODE OF ACTION; TEMP. AND PH
EFFECTS ON ACTIVITY; TEMP. STABILITY

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3. BE FAMILIAR WITH STARCH COOKING AND GELATINIZATION, EFFECTS ON
STARCH STRUCTURE

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Q U E S T I O N N A I R E

NO RESPONSE
NOT NEEDED
USEFUL
REQUIRED

SKILL OR KNOWLEDGE

MASHING (LIQUEFACTION AND SACCHARIFICATION) continued

	5	3	1	0
22. Be able to calculate the amount of acid or base needed to adjust pH.	4.56863			
23. Be able to weigh samples on a triple beam balance.	4.05882			
24. Be able to "zero" a balance for accurate readings.	4.29412			
25. Be able to convert grams to pounds and vice versa.	4.01961			

(O V E R)

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

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QUESTIONNAIRE

NO RESPONSE
NOT NEEDED
USEFUL
REQUIRED

SKILL OR KNOWLEDGE

FERMENTATION	SUPER REQUIRED	5	3	1	0
1. Be able to institute and maintain high degree of hygiene in fermenters, pumps, motors, valves, piping etc.	XX	4.54902			
2. Be able to read and interpret label instructions from commercial yeast suppliers.		4.54902			
3. Be able to culture a yeast inoculum.	SUPER REQUIRED XXX	3.7451			
4. Be able to count yeast population through a microscope. YEAST COUNT REFERS TO BACTERIA--NOT YEAST POPUL.		3.35294			
5. Be able to effectively use a microscope.		3.39216			
6. Be able to adjust and maintain proper temperature in fermenter.		4.58823			
7. Be able to adjust and maintain proper pH in fermenter.		4.5098			
8. Be able to measure volume of yeast for proper inoculation.		4.33333			
9. Be able to <u>purge fermenters</u> of CO ₂ before cleaning and sterilization. NO BIG DEAL HERE--MT THE TANK(looks like "& Air")		4.17647			
10. Be able to install and maintain venting apparatus on fermenters.		3.84314			
11. Be able to test for alcohol content in fermenters.		4.54902			
12. Be able to initiate and follow testing procedures during fermentation, i.e., pH, alcohol content, sugar content.		4.45098			
13. Be able to properly use laboratory distillation equipment.		3.94118			
14. Be able to operate and control agitation during fermentation. Not everyone agitates w/fermentation.		4.37255			

(O V E R)

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT

1. KNOW BASIC ANAEROBIC BIOLOGICAL METABOLISM

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QUESTIONNAIRE

NO RESPONSE
NOT NEEDED
USEFUL
REQUIRED

SKILL OR KNOWLEDGE

DISTILLATION

	5	3	1	0
1. Be able to read and interpret an alcohol hydrometer.	4.72549			
2. Be able to read and interpret a specific gravity hydrometer.	4.56863			
3. Be able to adjust temperature of solutions for accurate readings from hydrometers.	4.52941			
4. Be able to calibrate, utilize and interpret readings from a balance and pycnometer.	4.			
5. Be able to test stillage for alcohol content.	4.56863			
6. Be able to test stillage for moisture content.	4.41177			
7. Be able to adjust steam control valves for temperature control.	4.47059			
8. Be able to adjust beer flow control valves for temperature control.	4.52941			
9. Be able to adjust reflux control valves for temperature control.	4.52941			
10. Be able to convert gallons to proof gallons.	4.19608			
11. Be able to maintain adequate records of alcohol production and disposition for the BATF and State agencies.	4.37255			
12. Be able to calculate amounts of denaturant required by the BATF.	4.4902			
13. Be able to accurately complete reports to the BATF and State agencies.	4.21569			
14. Be able to properly clean an alcohol spill in the plant.	4.60784			
15. Be able to describe the function and basic theory of dehydrating alcohol by various methods, i.e., desiccant, ternary, molecular sieve.	3.47059			
16. Be able to explain the chemical and physical properties of alcohol regarding safety.	4.09804			

(O V E R)

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT

1. BE PATIENT AND THOROUGH

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2. NO SHORTCUTS

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Q U E S T I O N N A I R E

NO RESPONSE
NOT NEEDED
USEFUL
REQUIRED

SKILL OR KNOWLEDGE

ALCOHOL STORAGE AND HANDLING

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|---|---------|
| 1. Be able to identify storage tank materials that are compatible with alcohol. | 4.13725 |
| 2. Be able to identify pump components that are compatible with alcohol. AND ALCOHOL PRODUCTION (I.E. STILLAGE PUMPS) | 4.09804 |
| 3. Be able to properly vent alcohol storage tanks. | 4.35294 |
| 4. Be able to operate alcohol storage and pumping equipment. | 4.60784 |
| 5. Be able to test alcohol for proof and acidity. | 4.64706 |

(O V E R)

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT NEEDED

1. KNOW BASIC THERMODYNAMICS OF DISTILLATION INCLUDING VAPOR-
LIQUID EQUILIBRIA AND ENERGY AND MATERIAL BALANCES ☒ ☐ ☐
2. KNOW THEORY OF DISTILLATION, INCLUDING CONTROL SYSTEMS ☒ ☐ ☐
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Q U E S T I O N N A I R E

NO RESPONSE
NOT NEEDED
USEFUL
REQUIRED

SKILL OR KNOWLEDGE

STILLAGE STORAGE AND HANDLING

	5	3	1	0
1. Be able to operate a stillage separator and dewatering press.	4.4902			
2. Be able to identify proper disposal methods of thin stillage.	4.07843			
3. Be able to take a moisture sample of distillers grains.	4.03922			
4. Be able to perform a crude protein analysis of distillers grains.	3.33333			
5. Be able to formulate a balanced ration for different species of livestock using distillers grains.	2.94118			
6. Be able to calculate dry basis for wet stillage.	3.72549			
7. Be able to calculate price using either wet or dry stillage basis.	3.4902			
8. Be able to detect spoilage in wet distillers grains.	4.23529			
9. Be able to properly dispose of spoiled distillers grains.	3.96078			

(O V E R)

WE ARE EXPERIMENTING WITH SOLAR DRYERS.

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

NOT NEEDED

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QUESTIONNAIRE

NO RESPONSE
NOT NEEDED
USEFUL
REQUIRED

SKILL OR KNOWLEDGE

5 3 1 0

MAINTENANCE AND MINOR REPAIR OF EQUIPMENT

1. Be able to follow service manual recommendations and perform preventative maintenance on the following equipment:

A. Grain Grinders	4.27451
B. Grain Rollers	4.19608
C. Grain Augers and Elevators	4.31373
D. Grain Fans and Dryers	4.19608
E. Steam Boilers	4.11765
F. Air Compressors	4.11765
G. Hydraulic Systems	4.15686
H. Material Handling Equipment	
a. Pumps	4.23529
b. Motors	4.15686
c. Valves	4.19608
d. Pipe	4.23529
I. Stillage Separator	4.27451
J. Dewatering Press	4.15686
K. Stillage Dryer	4.15686

2. Be able to keep maintenance records on all equipment.

4.2549

(O V E R)

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

REQUIRED

USEFUL

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Q U E S T I O N N A I R E

NO RESPONSE
NOT NEEDED
USEFUL
REQUIRED

SKILL OR KNOWLEDGE

EQUIPMENT AND BUILDING

	5	3	1	0
1. Be able to identify different types of valves, i.e., gate, ball, globe, needle etc.	3.76471			
2. Be able to identify different types of pipe, i.e., galvanized, black, PVC, CPVC etc.	3.76471			
3. Be able to properly size pipe and valves for liquids, compressed air and fluids.	3.45098			
4. Be able to select proper type of pipe for specific purpose according to need and pipe manufacturer's specifications.	3.41177			
5. Be able to service boiler water treatment equipment.	3.68627			
6. Be able to read and interpret pressure gauges for water, air and fluids.	4.5098			
7. Be able to calculate temperatures from pressure readings.	4.31373			
8. Be able to identify different types of steam traps, i.e., float, thermostatic etc.	3.64706			
9. Be able to size steam traps to steam systems.	3.2549			
10. Be able to calculate heat loss from exposed pipes, vessels and building.	3.13725			
11. Be able to determine insulating values of insulation and other building materials.	3.13725			
12. Be able to interpret fire ratings of various materials used in construction and insulation.	3.2549			
13. Be able to identify different types of pumps, i.e., centrifugal, diaphragm, vacuum etc.	3.68627			
14. Be able to select proper type pump for specific purpose according to need and manufacturer's specifications.	3.37255			
15. Be able to identify different types of motors, i.e., electric, air, fluid etc.	3.84314			
16. Be able to select proper type motor for specific purpose according to need and manufacturer's specifications.	3.37255			

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

REQUIRED
USEFUL
NOT

- | SKILL OR KNOWLEDGE | REQUIRED | USEFUL | NOT |
|--|---|--------------------------|--------------------------|
| 1. BE ABLE TO DETERMINE PROPER BOILER SIZE NEEDED FOR SPECIFIED SIZE PLANT | ☒ XX | ☐ | ☐ |
| 2. BE ABLE TO DETERMINE PROPER COLUMN SIZE AND KIND | ☒ XX | ☐ | ☐ |
| 3. BE ABLE TO DETERMINE NEEDED COOKING EQUIPMENT & SIZE | ☒ XX | ☐ | ☐ |
| 4. BE ABLE TO DETERMINE NEEDED FERMENTATION FACILITIES | ☒ XXX | ☐ | ☐ |
| 5. BE ABLE TO DETERMINE BUILDING SIZE & CONSTRUCTION | ☒ XX | ☐ | ☐ |
| 6. | ☐ | ☐ | ☐ |
| 7. | ☐ | ☐ | ☐ |
| 8. | ☐ | ☐ | ☐ |
| 9. | ☐ | ☐ | ☐ |
| 10. | ☐ | ☐ | ☐ |
| 11. | ☐ | ☐ | ☐ |
| 12. | ☐ | ☐ | ☐ |

NOTE: YOUR SCHEDULE DEALS WITH SPECIFIC AND NOT THE LARGER UNIT EQUIPMENT. THIS IS EXPECIALLY NEEDED FOR THOSE WHO WANT TO BUILD THEIR OWN PLANTS.

QUESTIONNAIRE

NO RESPONSE
NOT NEEDED
USEFUL
REQUIRED

SKILL OR KNOWLEDGE

5 3 1 0

SAFETY

1. Be able to recognize unsafe conditions in the following areas:

A. Feedstock Preparation Equipment	4.4902
B. Grain Moving Equipment	4.4902
C. Boiler Operations	4.68627
D. Enzyme Storage and Handling	4.52941
E. Acid Storage and Handling	4.64706
F. Venting of CO ₂	4.60784
G. Distillation Procedures	4.64706
H. Alcohol Storage and Handling	4.64706
I. Stillage Separation Equipment	4.56863
J. Stillage Drying Equipment	4.52941
K. Stillage Storage	4.4902
L. Denaturant Storage and Handling	4.47059

2. Be able to install and maintain safety shields on all equipment.	4.21569
3. Be able to select proper firefighting equipment for an alcohol fire.	4.52941
4. Be able to correctly use firefighting equipment on an alcohol fire.	4.52941
5. Be able to administer CPR (Cardio-Pulmonary Resuscitation).	3.7451
6. Be able to administer basic first aid.	4.01961
7. Be able to maintain safety records on personnel.	3.86275

(O V E R)

PLEASE ADD ANY COMPETENCIES WE MAY HAVE
OVERLOOKED AND RATE WITH AN (X).

SKILL OR KNOWLEDGE

		REQUIRED	USEFUL	NO
		ALL		
1.	PLANT MANAGER	XX	☐	☐
2.	PRIMARY OPERATORS	AS MARKED XX	XX	☐
3.	SECONDARY OPERATORS	☐	XX	XX
4.	LABOR	☐	XX	XX
* FOLLOWING COMMENTS ARE FROM ONE RESPONSE --				
5.	We built a Mother Earth 3" still - portable - and demonstrate to farm and white collar groups wherever - whenever. Ag areas here are in mountain valleys and scattered. This demo. still cost + \$700.	☐	☐	☐
6.	So, we built a continuous operation 8" column still on campus to teach a 1 week construction and production workshop and to stockpile fuel for irrigation pump (a converted 1947 Model G tractor). Two of our field pickups run on ethanol.	☐	☐	☐
Most of your safety suggestions are part of our regular classes.				
8.	We are conducting stillage feeding tests and run batch tests of all feeds.	☐	☐	☐
9.	Our students are Navajo people and do a fine job of demonstrating the still to everyone. This is one of the major reasons we got involved with ethanol; to have Navajo students prove they are as capable as anyone else.	☐	☐	☐
10.		☐	☐	☐
11.		☐	☐	☐
12.		☐	☐	☐

ATTACHMENT G

"AC ENERGY" A. S. DEGREE PROGRAM
COURSES

AG ENERGY

FIRST SEMESTER

Physical Education	1
Intro to Ag Occupations	1
Intro to Soils	3
<u>INTRO TO AG ENERGY</u>	3
Plant Science	3
English	3
Mathematics	3
	17

SECOND SEMESTER

Animal Science	3
<u>CHEMISTRY OF ENERGY PROCESSES</u>	3
Business Communications	3
Occupational Internship	8
	17

SUMMER SEMESTER

Occupational Internship	8
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THIRD SEMESTER

Employment Seminar	½
Ag Economics	3
Physical Education	1
Accounting I	3
Humanities	3
<u>INTRODUCTORY AGRICULTURAL BIOLOGY</u>	3
<u>ALCOHOL FUELS I</u>	3
Electives:	0-3
Animal Nutrition	3
Soil Fertility and Fertilizers	2
Beef Production	3
Ag Finance	3
Principles of Management	3
	16½-19½

FOURTH SEMESTER

<u>ALCOHOL FUELS II</u>	5
<u>AG ENERGY PRODUCTION</u>	3
<u>SOLAR ENERGY: THEORY AND APPLICATIONS</u>	3
History	3
Electives:	3-6
Swine Production	3
Farm Chemicals	3
Ag Credit and Finance	3
Marketing Farm Commodities	3
Accounting II	3
Public Speaking	3
Business Law	3
Grain and Seed Harvesting Equipment	5
	17-20

ATTACHMENT H

AMERICAN JOBS FROM ALCOHOL FUEL

ATTACHMENT I

ALCOHOL FUELS PRODUCTION,
MANPOWER, AND EDUCATION:
WHERE DO TWO-YEAR COLLEGES FIT?

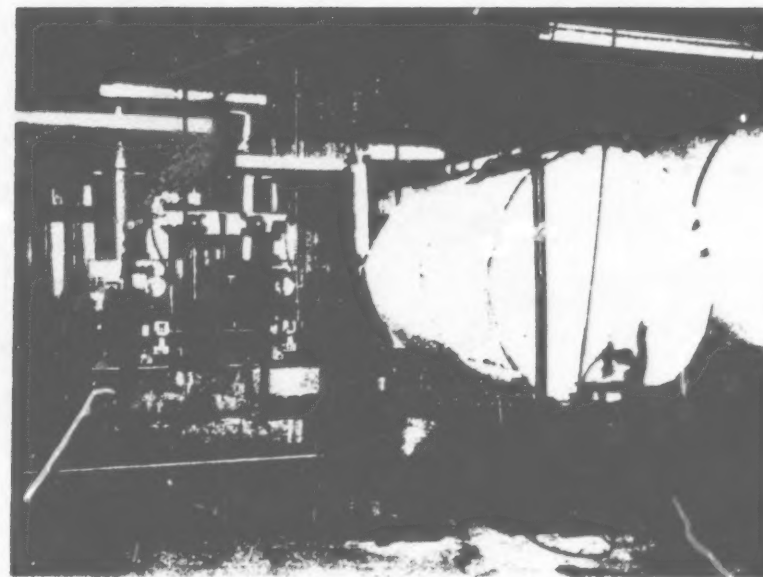
ATTACHMENT J

FACILITIES AND EQUIPMENT



DISTILLATION COLUMN - 40 ft. tall, 12 inches in diameter. This column is a sieve tray column capable of producing 190 proof alcohol at the rate of 20 gallons per hour. The column is manufactured by Osage Plains, Inc., Butler, Missouri. Their Registered Trademark is FARMACOL. A condenser is attached to the side of the column.

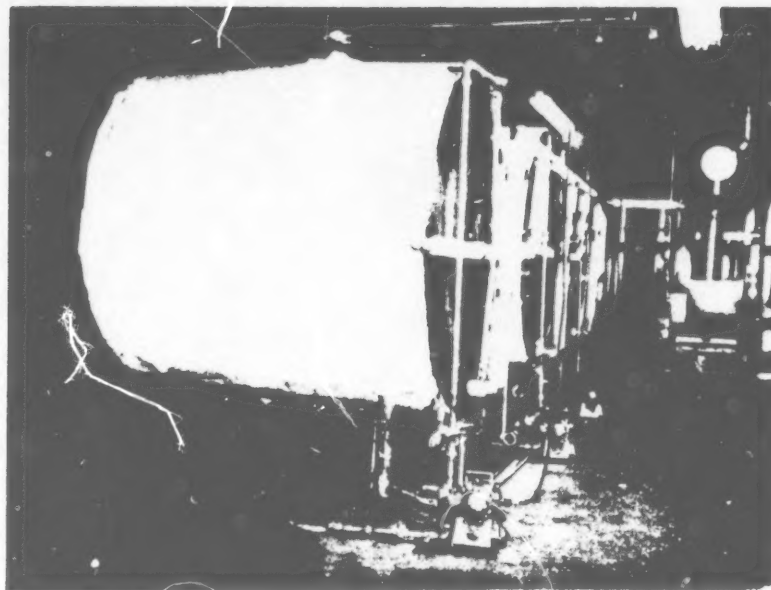
HEAT EXCHANGER - Steam is used to pre-heat the fermented mash before the mash enters the distillation column.



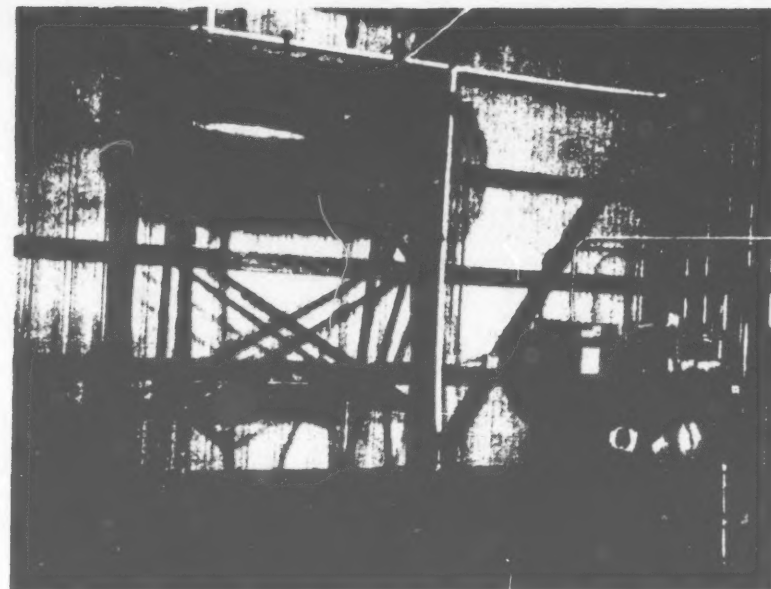
STEAM BOILERS - Two 15 pounds per square inch steam boilers with an output of 180,000 BTU's each. Steam is used to cook the mash and during distillation.

MIX TANK - Small "V" bottom tank used to mix grain, enzymes, acids and water during the cooking process.

SMALL COOKER/FERMENTER - This tank is 4 feet in diameter and 6 feet long, constructed of 10 gauge mild steel. The tank is equipped with a mixing auger, (6 inch grain auger with flighting reversed in the center), a steam jacket and a 2 feet square manhole in the top. The tank is covered with 1 inch of fiberglass insulation and a plastic outer skin. The tank holds 560 gallons.

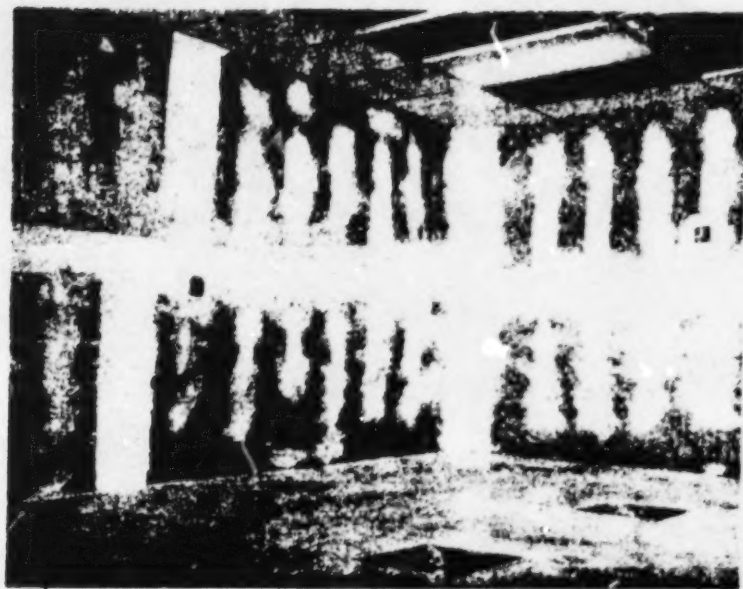


LARGE COOKER/FERMENTERS - These tanks are 6 feet in diameter and 6 feet long, constructed of 10 gauge mild steel. Each tank holds 1,270 gallons and is equipped with augers and steam jackets, the same as the small Cooker/Fermenter.



AIR COMPRESSOR - The mash pumps and agitators are powered with air. The compressor is a GARDNER-DENVER Electra-Screw (R), Model BESCG-H 10 H.P., and was DONATED to the College by Gardner-Denver.

REFLUX TANK - This tank holds 300 gallons of alcohol that is injected into the top of the distillation column for temperature control. The tank is a standard fuel storage tank with a stainless steel, on demand, air operated pump.



LABORATORY

The interior of the building has been the project of the AVTS Building Trades class since September 1980. The students have insulated the building to an R-19, covered the walls with 5/8" fire-retardant sheet rock, installed a suspended ceiling and partitioned the floorspace into a laboratory, two restrooms, a mechanical room, and open area for the fuel alcohol distillation equipment.



HALLWAY AND RESTROOMS ON THE LEFT

The laboratory will be furnished with lab tables, (complete with sink and bunsen burners), lab stools, blackboard, overhead screen, and lectern. The laboratory will be used for teaching the Ag Energy courses and as a Quality Control Laboratory during the hands-on experience phase of training for the students.